American POTATO JOURNAL

Volume 27 | *August, 1950* | *Number 8*

CONTENTS

III. Selection for Resistance to Mosaic Virus (Diseases) in Wild Species and in Hybrids of Wild Species of Potatoes—*H. Ross and M. L. Baerecke* 275

Costs of Potato Production in Central and Western Ontario, Canada *H. L. Patterson and Earl Haslett* 285

Injury Studies on Idaho Grown Russet Burbank Potatoes. Part I. Shipping and Handling—*Walter C. Sparks* 287

Sectional Notes 303

Official Organ of

THE POTATO ASSOCIATION OF AMERICA

NEW BRUNSWICK, NEW JERSEY

American Potato Journal

PUBLISHED BY

THE POTATO ASSOCIATION OF AMERICA

NEW BRUNSWICK, N. J.

$2.00 per year, United States and Canada, $2.50 per year elsewhere.

Entered as second class matter at New Brunswick, N. J., March 14, 1942, under Act of March 3, 1879.

Accepted for mailing at special rate of postage provided for in section 412, Act of February 28, 1925, authorized on March 14, 1928.

III. SELECTION FOR RESISTANCE TO MOSAIC VIRUS (DISEASES) IN WILD SPECIES AND IN HYBRIDS OF WILD SPECIES OF POTATOES

H. Ross and M.-L. Baerecke

Max-Planck-Institut für Zuchtungsforschung (Erwin-Bauer-Institut), West Germany, Germany

(Accepted for publication January 3, 1950)

A. Introduction

As shown by extensive investigations about creation of virus resisting varieties of the potato by cross-pollination of the varieties to each other, for immunity from virus, to date there is no evidence of the existence of genes in pure *S. tuberosum* varieties*. The few cultivated varieties of potatoes with immunity, such as USDA-Seedling 41956 from virus X (Dykstra 1935) and some others, go back to crossings with wild species. This negative result of an extensive work of crossing and selection also shows spontaneous mutations toward immunity or resistance to happen extremely seldom or not at all.

After tests of the Institute's collection of wild species for resistance to Phytophthora and to the Colorado beetle (Lehmann 1937, Schaper 1938) had

*In the tests for resistance to virus Y, for example, in our Institute no immune cultivated variety could be found out of 77.

revealed homozygotically as well as heterozygotically-resisting species among them, it seemed advisable to test the collection for resistance to virus, too. This was carried out from 1939-1944 by Stelzner as a preliminary test, aiming at first at a general survey on the material for resistance after infection with virus X (incl. B), Y, A and leafroll virus. In 1940-1941 the wild species, looking most promising for resistance to virus X and Y, *S. antipoviczii, S. ajuscoense* and *S. acaule*, were infected and tested for immunity by sap-inoculation on tobacco. In the same manner the progeny of such leafroll-infected seedlings of *S. chacoense*, which had shown no symptoms in the year of infection were tested by grafting on a susceptible cultivated variety.

All the selected clones were lost during the war, although some of the hybrids, in which they entered as parents, were saved. Therefore a new selection was necessary, which was carried out in 1947-1948 for immunity from virus X, B (closely related to X) and Y by Ross and for immunity from leafroll virus by Baerecke. As the preliminary selection had revealed the existence of types, that are immune from virus B and X respectively and Y, all available wild species and hybrids with them were tested for immunity. Every seedling, which remained without symptoms, was in the same year tested back on tobacco. With leafroll, work was done correspondingly. Furthermore, attention was paid to types reacting with total necrosis to infection with virus X, B and Y, for, as will be explained later, these types may prove to be of importance as starting material for breeding. This selection was a re-examination, too, of the results of the preliminary selection, which led generally to a confirmation. There also was seen that in the tests with virus X and B respectively, and Y, a high rate of the plants without symptoms may be called immune, because, contrary to cultivated varieties, wild species almost invariably show symptoms when virus X and B respectively, or Y is present.

B. Material

The wild species used for selection were collected partly by the South America Expedition of our Institute made by Baur and Schick in 1930. The collection from time to time was supplemented by consignments from private persons in America. We especially owe supplies to Professor Posnansky, La Paz, and Dr. Reddick, Ithaca. Further valuable supplements to our collection were received by exchange with Professor Bukasov, Leningrad. The fact must also be mentioned that by growing in virus-infested areas, combined with selection and roguing the material, the material used for the main selection had already undergone a pre-selection for resistance to virus.

C. Methods of the Preliminary Selection (Stelzner 1939-1943)

It would have been desirable to propagate the seedlings of the wild species as clones first, before they were tested, in order to test them for resistance to

each virus. However, this was not carried out, for many wild species can hardly be made to produce tubers, and only when grown from true seed the material to start with will, with safety, be free from virus.

A part of the seedlings was infected by inoculation with sap of potato plants, another part by grafting, and one third was infected by aphids (*Myzus persicae*). For the infections, use was made of the variety Erstling (Duke of York), which is a latent carrier of virus B, and of the variety Zeeuwsche Blauwe, which carried Y and C (Ross 1950). Infection with virus A was induced by sap-inoculation and grafting of the variety Juli. Leafroll infection was done by grafting the virus containing scions on the seedlings. The presence of the respective viruses was continuously confirmed in Zeeuwsche Blauwe and Juli. Then selecting for immunity from virus X and Y in 1940-1941 in *S. acaule*, *S. ajuscoense*, and *S. antipoviczii*, the seedlings were infected for the first time shortly after the formation of the second and third leaf. *S. ajuscoense* and *S. antipoviczii*, after discarding diseased plants, were, in addition, grafted with scions of Zeeuwsche Blauwe, which were removed again after four weeks. Those seedlings of the three species, which remained without symptoms underwent backtesting for their content of virus on proper indicator plants. The original seed was derived from seedlings, which previously had shown no symptoms.

Tests for immunity from leafroll were conducted by grafting scions of wild seedlings, so far without symptoms, on plants of a cultivated variety, susceptible to leafroll (For more information see Stelzner 1949.).

D. Methods of the Main Selection

In 1947-1948 wild species and their hybrids were tested with respect to their reaction against virus X, Y and the leafroll virus. For virus X and Y only sap-inoculation was applied. In order to get the symptoms, characteristic for each virus, we endeavored to use pure strains of virus for infections. For this purpose a strain of virus X was isolated from the variety Odenwaelder Blauwe, which had to be separated by heating at 62°C. from virus Y, also present in Odenwaelder Blauwe. By means of repeated passages on 10 plants of tobacco var. Samsun, using sap, diluted 1 : 10.000, a pure strain was obtained with uniform symptoms. The same thing was done with a second strain of virus X from the variety Carnea. For infection with virus Y the strains Go 16 and GA were used, which Dr. Koehler has kindly put at our disposal.

The first inoculations with virus X and Y were made in the planting box, after the seedlings were about 5 inches (12cm) high. There ,too, the first selection took place, when approximately 50 per cent of the seedlings were killed by the disease. After a second inoculation the seedlings were put into a hotbed or planted in the open field. There further selections took place as well

as a third inoculation of those plants, which so far had been without symptoms.

In the hot-beds the occurrence of early blight was especially inconvenient as it rendered it very difficult to judge the symptoms. Also further inoculation became necessary, as the leaves sometimes died so fast that possibly the virus was not allowed to spread. In most cases the seedlings regenerated their foliage as time went on. *Pinnatisecta* and *Arraciana* suffered most from early blight. In the same open field it was *Phytophthora infestans* that created the same obstacle.

Seedlings showing no symptoms were retested on *Nicotiana tabacum* vars. Samsun and White Burley, *N. glutinosa*, *Datura* and *Capsicum*. In addition, part of the test was also carried out with the serological method by Dr. Stapp, Brunswick, to whom we are indebted. In many wild seedlings the inoculated virus was weakened to a strain showing non-necrotic mottle-symptoms on the test plants, which at certain seasons can be observed but with many difficulties. In such cases virus Y was added by inoculation, which lead to characteristic symptoms for this mixed infection. Whenever detection of virus Y became difficult, there was an additional inoculation made on the tobacco plant after 10 days with a necrotic strain of virus X of the group XN. Thereafter characteristic symptoms of the X-Y-mixture became visible, although in winter frequently only after four weeks.

In 1947 only two inoculations and two tests per plant were possible. Clones, which had passed these exposures and tests without symptoms were again inoculated in 1948. Of those, originally thought to be immune, about 20 per cent were thus eliminated as attacked by the virus. The seedlings of the year 1949 shall be inoculated four times.

As a contrast to the viruses of mosaic, leafroll virus is transmissible only by grafting or with the help of aphids. Symptoms after field infection in the first year are often so faint, that for safe diagnosis reexamination in the following year is necessary. These two facts have given a setback to breeding for resistance to the leafroll virus although this virus affects the biggest losses.

The preliminary selection by Stelzner 1939-1943 brought about a first separation of extremely susceptible species from tolerant ones. Using the conclusions from the preliminary test 1947-1948 exposures were not made by grafts but by aphids (*Myzus persicae*). This method made possible inoculations on very young seedlings immediately after formation of the first leaves and so induced reaction as strong as possible in the first year. The technique used was to put two viruliferous aphids on each seedling about one week after the first transplantation. This was followed at intervals of some days by a second infestation of two viruliferous aphids per seedling. About a week later the plants were sprayed with the insecticide E 605 in order to avoid damage from feeding. These plants, which, at the end of summer were still

TABLE 1—*Resistance in wild species of potatoes to X-, B-, Y-, A- and leafroll-virus. First selection 1939-1944 (Stelzner)*

	Species *Solanum*	No.	Subspecies	Virus B a	Virus B b	Virus Y 1939 a	Virus Y 1939 b	Virus Y 1940/41 a	Virus Y 1940/41 c	Virus A a	Virus A b	Leaf-roll Virus a	Leaf-roll Virus b
Commersoniana Buk.§	*chacoense* Bitt.	1	La Pampa	11	3	14	0			8	3	5	1
		2	Siambon	12	0	18	1			2	1	0	12
		3	Paraguay	25	5	10	11			5	1	6	3†
		4	Agraciada	12	0	15	9			0	2	12	0
		5	Bukasov	3	0	10	1			1	8	0	9†
	cordobense Buk.	6	....	2	0	8	0			0	2	10	0
	caldasii Dun.	7	....	4	0	9	7			3	0	....	....
	garciae Buk. et Juz.	8	....	10	0	10	1			6	0	8	0
Araccia-na Buk.	*bukasovii* Juz.	9	....	0	9	11	11			2	3	1	0
Longipedicellata Buk.§	*ajuscoense* Buk.	10	....	3	0	8	8	96	15‡	3	0	....	....
	antipoviczii Buk.	11	Reddick 580	1	2	2	5			6	0	....	....
		12	Reddick 560	1	2	4	8			5	0	7	0
		13	Reddick 558	21	1	0	51	184	7‡	5	1	6	0
		14	Reddick 557	2	0	0	10	99	1‡	2	1	....	....
		15	Reddick 555	3	0	10	18			2	9	....	....
		16	USDA	9	0	4	10			2	6	6	0
		17	Stelzner	2	2	5	1			3	6	4	0
Demissa Buk.§	*verrucosum* Schlechtd.	18	Reddick 570	3	0	4	15			0	2	6	0
		19	Reddick 551	12	3	9	13			0	10	5	0
		20	Reddick 549	6	2	2	22			4	2	3	0
		21	El Mirador	3	2	3	8			0	4	6	0
	demissum Lindl.	22	*v. xitlense* Buk.	5	1	20	0			6	3	12	0
		23	*v. utile* Klotzsch	2	0	9	11			11	0	3	0
		24	Rio Frio	4	1	12	4			8	0	2	0
		25	Bukasov 029	3	0	6	1			0	9	7	0
		26	Bukasov	7	1	36	0			10	1	0	4
		27	Stelzner	2	2	5	0			5	5	....	....
Borea-lia Buk.	*fendleri* A. Grey	28	....	6	0	12	26			6	0	12	0
Acaulia Juz.	*acaule* Bitt.	29	Blossfeld	0	5*	7	2			4	2	6	0
		30	San Jose	0	6*	0	0			1	2	5	0
		31	La Pena blanca	0	20*	3	6			2	3	3	0
		32	Bukasov	0	9*	6	6			1	7	....	....

a=With symptoms. b=Without symptoms. c=Immune.

*=In 1941 other seedlings were infected with Virus X from Jubel and tested on *Capsicum annuum*. Some of them contained X (=tolerant) and some not (=immune). All plants of San José were susceptible.

†=All infected seedlings without symptoms contained the virus (=tolerant).

‡=This is the only number of the tuber-bearing tested immune seedlings.

§=Following the classification of Bukasov (1937, 1939 and in Kameras 1940) and Hawkes 1944.

TABLE 2—*Resistance in wild species of potatoes to X-, Y- and leafroll-virus. Preliminary results of the main selection 1947 and 1948*
(ROSS and BAERECKE)

Group	Species *Solanum*	No.	Subspecies	Virus X			Virus Y			Leafroll-Virus	
				a	b	c	a	b	c	a	b
Commersoniana Buk.	*chacoense* Bitt.	1	Siambon 2n	184	2	0	127	8	4	110	1
		2	Siambon 4n	57	1	0	35	1	0	58	3
	cordobense Buk.	3	*colchiziniert*	37	0	0	17	0	0	29	0
	garciae Juz. a. Buk.	4	....	....	....	....	7	2	0	....	....
Aracciana Buk.	*macolae* Buk.	5	....	28	3	0	10	0	0	24	....
	catarthrum Juz.	6	....	51	3	0	64	5	2	75	2
Longipedicellata Buk.	*ajuscoense* Buk.	7	....	6	1	0	20	0	2	2	....
	antiporiczii Buk.	8	USDA*	35	0	0	54	3	5	32	0
Demissa Buk.	*verrucosum* Schlechtd.	9	Reddick 570*	9	0	0	....	....	....	13	0
	demissum Lindl.	10	*v. xitlense* Buk.	10	0	0	13	0	0	....	....
		11	*v. tlaxpehualcoense* Buk.	13	0	0	11	0	0	....	....
		12	*v. utile* Klotzsch	20	0	0	77	0	0	8	....
		13	Reddick 521	48	0	0	52	1	0	5	....
		14	Bukasov 029*	19	0	0	18	4	0	....	....
		15	ElDesierto	33	3	0	29	4	0	....	....
Eutuberosa Buk.	*wittmackii* Bitt.	16	....	21	0	0	....	....	....	16	0
	leptostigma Juz.	17	....	....	....	....	....	....	....	9	0
Andigena Buk.	*andigenum*	18	....	....	....	....	....	....	....	2	2
Polyadenia Buk.	*polyadenium* Greenm.	19	2n	19	0	0	44	2	0	27	....
Acaulia Juz.	*acaule* Bitt.	20	Bitter (prostrate)	10	0	6	50	4	0	....	....
		21	v. Rosenstiel (pros.) *Bitt. (pros.)	13	0	12	14	0	0	....	....

a=Susceptible.
b=Without symptoms after infection, tests not yet finished.
c=Immune.
*=Possibly this seed comes from Stelzner's selected parent plants.

TABLE 3—*Resistance in hybrids of potato species to X-, Y- and leafroll-virus. Preliminary results of the main selection 1947 and 1948.*
(ROSS and BAERECKE)

								Leafroll-Virus			
		Virus X			Virus Y			1. Series		2. Series	
No.	Crosses	a	b	c	a	b	c	a	b	a	b
1	*chac.* Siamb. x Edelgard	1	0	0	6	0	0	....	....	7	0
2	Ackersegen x *chac.* Siamb. 4n	....	....	....	4	0	0	....	....	6	0
3	*chac.* 4n x Flava	10	0	0	....	....	....	....	....	13	0
4	(*chac.* 4n x Flava) x fr	....	....	....	....	....	....	36	0	....	....
5	(Falke x *chac.* Siamb.) x fr.	8	1	0	12	6	2	17	....	....	....
6	(*chac.* Lima x Pepo) x Flava	....	....	....	....	....	....	21	1	....	....
7	[(*chac.* Siamb. x Pepo) x (*chac.* Siamb. x Erika)] x s	3	0	0	....	....	....	....	....	5	0
8	*chac.* 4n x Phyt. Klon	....	....	....	....	....	....	....	....	7	....
9	(*commers.* x Erika) x ([(*chac.* Siamb. x *tub.*) x tub.] x *chac.* S.)	....	....	....	4	0	2	12	0	4	0
10	(*laplatic.* x *schickii*) x *chac.* 4n	....	....	....	10	0	0	2	0	....	....
11	*catarthrum* x *chac.* Siambon	7	0	0	....	....	....	....	....	7	0
12	*chac.* W 42/57 x *S. macolae*	....	....	....	....	....	....	19	0	....	....
13	([(*chac.* Siamb. x *tub.*) x s] x *chac.* Siamb.) x (*chac.* Siamb. x *macolae*)	10	0	0	8	0	0	....	....	45	0
14	Kreuzung 13 x s	20	0	0	15	0	0	17	0	....	....
15	(*chac.* Siamb. x *phureja*) x Carnea	....	....	....	....	....	....	15	0	....	....
16	[*chac.* Siamb. x (*chauca* x *ryb.*)] *x s*	7	3	0	13	2	2	....	....	....	....
17	[(*chac.* Siamb. x *tub.*) x *chac.* Siamb. 4n] x [(*dem.* x *chac.* Siamb.) x s]	4	0	0	....	....	....	....	....	6	0
18	Kreuzung 17 x s	20	0	0	7	0	0	7	0	....	....
19	[(*dem. tlaxpehualcoense* x *rybinii*) x*chac.* Siamb.] x Edelgard	20	0	0	10	3	0	16	0	....	....
20	*chac. res.* x *polyadenium*	....	....	....	....	....	....	3	0	....	....
21	(*polyadenium* x *chac.* Siamb.) x s	....	....	....	7	1	3	....	....	10	0
22	(Ackersegen x *polyad.* 4n) x *chac.* 4n	....	....	....	2	1	0	1	0	....	....
23	(Ackersg. x *polyad.* 4n) x [(*chac. S.* x *tub.*) x *tub.*] x *chac.* Siamb.	....	....	....	2	1	2	....	....	15	0
24	*cordobense* x Aquila	7	0	0	....	....	....	....	....	....	....
25	*cordobense* x Flava	....	....	....	....	....	....	8	0	....	....
26	(*cordobense* x Aquila) x s	15	0	0	13	3	4	12	0	....	....
27	[(*cordobense* x Edelgard) x s] x s	22	0	0	11	1	0	9	0	....	....

TABLE 3—*(Continued)*

								Leafroll-Virus			
		Virus X			Virus Y			1. Series		2. Series	
28	(*catarthrum* x Ackersegen) x s	....	....	....	10	1	0	16	0	....	....
29	(*cordobense* x *macolae*) x s	63	1	0	18	9	0	30	0	....	....
30	[(*dem.* Rio Frio x *verrucosum*) x Flava] x s	19	1	0	17	2	0	11	0	....	....
31	*mac.-tub.-dem.*-Bastard	22	0	0	....	....	....	16	0	....	....
32	*garciae* x Vorant†	13	0	0	7	4	2	8	0	....	....
33	(*garciae* x Edelgard) x s†	25	0	0	10	2	2	....	....	12	0
34	(*garciae* x *tub.*) x s†	5	0	0	....	....	....	12	0	....	....
35	(*garciae* x Edelgard) x Carnea†	....	....	....	....	....	....	18	0	....	....
36	(*gibberulosum* x *macolae*) x s	....	....	....	14	0	0	....	....	7	0
37	(*gibberulosum* x *macolae*) x mac.	19	0	0	22	3	0	....	....	....	....
38	(*goniocalyx* x *gibberulosum*) x s	5	0	0	2	0	0	2	0	....	....
39	(*commersonii* x Erika) x s	3	0	0	2	0	0	....	....	....	....
40	([(*dem. utile* x *ryb.*) x Edelgard] x Mittelfrühe) x s	....	....	....	5	1	0	10	0	....	....
41	(*antipov.* USDA x Erika) x s†	....	....	....	9	4	3	....	....	16	0
42	(Ackerseg. x *polyad.* 4n) x s	7	0	0	1	4	5	....	....	18	0
43	[(Ackersg. x *polyad.* 4n) x s] x s	15	0	0	19	1	0	36	0	....	....
44	Wittmackii x Flava	25	0	0	....	....	....	19	0	....	....
45	(BRA‡-Stamm 9098 x Edelgard) x s	50	1	0	43	5	2	50	0	....	....
46	(BRA-Stamm 9089 x Edelgard)	....	....	....	....	....	....	15	0	....	....
47	*cordobense* x *andigenum* Bast.	....	....	....	....	....	....	17	0	....	....

a, b, c=See Table 1.

†=The wild parents of these hybrids are possibly by Stelzner already selected as resistant plants.

‡=Biologische Reichsanstalt.

without symptoms in the field again had 10 additional aphids put on them under a paper bag for inoculations.

The test aphids picked up the virus from leafroll-infected pot-plants of the varieties Juli and Früehbote, on which they had been strongly propagated during the spring.

At the end of the year it was observed that nearly all seedlings were diseased. To be sure all plants were tested whether they possessed phloem necrosis or not, the method applied was to take from each plant near the soil a piece of stem of approximately 2 inches and to fix it in 70 per cent alcohol.

Later sections of the stem on slides were stained by Fuchsin (diluted 1 : 10.000 in buffer of KH_2PO_4 of $PH_{4.5}$), as described by Bode (1947). Without any exception all plants having rolled in the summer possessed more or less extended colored destructions in the phloem. Likewise, most of the plants with no or very faint and quick passing symptoms in the first year proved by this test to be susceptible to the virus. Thus only a few individuals remained symptomless in the descendants of nearly 2000 tested plants as shown in tables 2 and 3. These shall be tested by indicator plants such as *Physalis* spec. (Hovey and Bonde 1948, Kirkpatrick 1948).

It needs to be stressed that the figures of immune plants which have been compiled to date are by no means final, since infections as well as tests may fail for technical reasons. Even the survival of 4 and 5 inoculations without symptoms is no absolute guarantee for immunity. Final results will be recorded in future extensive publications by Baerecke and Ross.

E. Results: (See Tables 1, 2 and 3)

In the preselection there were tested 11 wild species represented by 32 geographical variants with about 1100 seedlings, and in the main selection 14 wild species in 21 variants and 49 hybrids with about 3000 seedlings. Naturally this material is only, in a few cases, sufficient to gain a real picture of the species or the hybrids.

1) *X-immunity*

X-immunity was, until the present, found with certainty only in *S. acaule*, which stands aside in the system. In this case we, in 1947, selected several immune plants, all the descendants of which showed immunity from X and B. Therefore, we conclude to have found a homozygote immune *S. acaule* plant. Some others gave a mixed descendance of immune and non-immune seedlings.

2) *Y-immunity*

Y-immunity is spread among a group of species, which is not uniform in systematic position nor chromosome number, nor in geographic distribution. We found Y-immunity in *S. chacoense*, *S. cordobense*, *S. garciae*, *S. catarthrum*, *S. macolae*, *S. ajuscoense*, *S. antipoviczii* and *S. polyadenium*, possibly also in *S. demissum*, *S. chaucha*, *S. rybinnii*, and *S. commersonii*. The results with the latter species are not yet verified. It is of great interest to take into consideration the genetical basis of immunity. The ready transmission in F_1 and F_2 could be observed.

3) *A-immunity*

Here the investigations are not so far advanced, but A-immunity seems to be as general as Y-immunity.

4) *Leafroll-immunity*

Only the species *S. chacoense* and with the nearly related *S. catarthrum* and *S. andigenum* give hope to find immune plants among them. All hybrids with *S. tuberosum* except one with *S. chacoense* show leafroll. *S. polyadenium* and its *S. tuberosum* hybrids appear remarkable for their high tolerance, seldom showing symptoms in the year of infection and possess only very faint necroses in the phloem.

5) *Method of Breeding*

The most important virus is, no doubt, the leafroll virus. It seems that only in *S. chacoense* and *S. andigenum* immunity against this virus is to be found. Aside from this *S. chacoense* possesses Y-immunity and a high degree of resistance against the Colorado beetle (Torka 1949). Therefore this species may be the most suitable for starting resistance-breeding. As a carrier of X-immunity genes, *S. acaule* must be taken into account and as a carrier of phytophthora-resistance, *S. polyadenium*, which is suitable to intensify the Y- and the Colorado beetle-immunity, is also important.

Literature Cited

1. Bode, O. 1947. Beitrag zum frühzeitigen Nachweis der Blattrollkrankheit Kartoffel durch anfärben des Phloems. "Festschrift Appel," Biol. Zentralanstalt.
2. Bukasov, S. M. 1939. Selection of the potato. Handbook for Plant Breeding (Edited by Vavilov, 1939).
3. ———. 1939. Interspecific hybridization in the potato. Physis 18:269.
4. Dykstra, T. P. 1935. A top-necrosis virus found in some apparently "healthy" potatoes. Phytopath. 25:1115.
5. Hawkes, J. G. 1944. Potato collecting expeditions in Mexico and South America. II. Imperial Bureau of Plant Breed. and Genet.
6. Hovey, C., and R. Bonde. 1948. *Physalis angulata*, a test plant for the potato leafroll virus. Phytopath. 38:505-507.
7. Kameraz, A. J. 1929. Wild species as initial material in potato breeding. Sov. Pl. Ind. Res. 4:13-29.
8. Kirkpatrick, H. C. 1948. Indicator plants for studies with the leafroll virus of potatoes. Amer. Potato Jour. 25:283-290.
9. Lehmann, H. 1937. Das heutige Ausgangsmaterial für die Züchtung *Phytophthora* widerstandsfähiger Kartoffeln. Züchter 9:29-35.
10. Ross, H. 1950. Resistenz gegen die Viren X, B, Y und C bei Kartoffelwildarten. (In press).
11. Schaper, P. 1938. Verhalten verschiedener Wildspezies gegen den Kartoffelkäfer. Mitt. Biol. Reichsanstalt Heft 58-62.
12. Stelzner, G. 1949. Virusresistenz der Wildkartoffeln. Zeitschrift f. Pflanzenzchtg. (In press).
13. Torka, M. 1948. Resistenz von *S. chacoense* gegen *Leptinotarsa decemlineata* und ihre Bedeutung für die Kartoffelzüchtung. Ztschr. f. Pflzchtg. 28:63-78.

Paper reviewed by Dr. E. S. Schultz, Beltsville, Md.

COSTS OF POTATO PRODUCTION IN CENTRAL AND WESTERN ONTARIO, CANADA

(Based on a sample survey in 1949)

H. L. PATTERSON and EARL HASLETT

Farm Economics Branch, Ontario Department of Agriculture, Toronto, Canada

(Accepted for publication May 20, 1950)

Costs of producing potatoes have been analyzed up to marketing time for twenty farms in Central Ontario and fifty farms in Western Ontario[1]. Marketing costs will be calculated later.

Labor represented over one quarter of the total cost as you will observe in table 1. Materials such as seed, fertilizer and spray were still more important and equalled nearly one-half of the total cost. The overhead costs are three per cent of the total. Although this is small on a percentage basis, it is still an item of approximately four dollars an acre.

TABLE 1—*Costs per acre by sources.*

Cost Items	Average of 50 Farms in Western Ontario	Average of 20 Farms in Central Ontario	Average of All 70 Farms	
	Value	Value	Value	Total Per Cent
Man Labor	$ 38.08	$ 42.56	$ 39.09	27
Machinery	10.77	14.08	11.51	8
Tractor Time	9.37	12.21	10.01	7
Horse Time	7.96	7.21	7.79	5
Misc. (meals, custom work, mileage, etc.)	5.38	3.08	4.86	3
Materials	62.44	84.86	67.47	47
Overhead	3.80	4.18	3.89	3
Total	137.80	168.18	144.62	100

HOURS—About one-half of the labor is spent on the harvesting of the

TABLE 2—*Hours man time used per acre of potatoes.*

	Average of 50 Farms in Western Ontario	Average of 20 Farms in CentralOntario	Average of All 70 Farms	
	Hours	Hours	Hours	Total Per Cent
Seed Bed Preparation	12	12	12	17
Planting and Seed Preparation	12	14	13	18
Summer Operations	11	11	11	16
Harvesting	34	37	34	49
Total Man Hours	69	74	70	100
Total Tractor Hours	17	19	17	
Total Horse Hours	19	16	18	

[1] Central Ontario Counties were Durham, Ontario and York.
Western Ontario Counties were Dufferin, Peel, Simco North, Simcoe South, Waterloo and Wellington.

potatoes as noted in table 2. Apparently Central and Western Ontario do not differ much in the use of labor.

The tractor was used more in preparing the ground than in any other phase of the work but also played an important part in the harvesting operations. Horses are used mainly in preparing the ground. Horse hours are high in seed-bed preparation because horses were used to a large extent in drawing out the manure.

MATERIALS—Sixteen bags of seed potatoes were planted to the acre on the average in Central Ontario, and fourteen bags in Western Ontario. Growers in Central Ontario applied an average of 10 loads of manure to an acre, and nine loads were applied in Western Ontario. Central Ontario growers applied an average of 1366 pounds of fertilizer per acre and Western Ontario 1027 pounds. The two areas averaged 1103 pounds per acre.

TABLE 3—*Costs per acre.*

Cost Items	Average of 50 Farms in Western Ontario	Average of 20 Farms in Central Ontario	Average of All 70 Farms	
	Value	Value	Value	Total Per-Cent
1. Labor, Power, Machines, etc.				
Seed bed preparation	$ 18.99	$ 19.98	$ 19.22	13.3
Planting and Seed Preparation	10.29	11.60	10.58	7.3
Summer Operations	13.41	14.27	13.60	9.4
Harvesting	28.87	33.29	73.26	20.7
Total	71.56	79.14	73.26	50.7
2. Materials Used				
Seed	22.27	32.10	24.48	16.9
Barnyard Manure	7.56	7.73	7.60	5.2
Commercial Fertilizer	21.29	28.61	22.93	15.9
Spray and Dust	10.10	15.64	11.35	7.8
Misc. (green manure, seed treatment, etc.)	1.21	.78	1.11	.8
Total	62.44	84.86	67.47	46.6
3. Overhead				
Taxes	1.32	.86	1.22	.9
Interest	2.30	2.61	2.37	1.6
Rent	.18	.71	.30	.2
Total	3.80	4.18	3.89	2.7
(Totals of 1, 2, & 3) GRAND TOTAL	137.80	168.18	144.62	100.0

Labor, power and machinery costs are high in harvesting and in seed-bed preparation as shown in table 3. This is because of the high man hours used in harvesting and the high tractor and horse hours used in preparing the seed-bed.

The big costs in the materials section are seed potato costs and commercial fertilizer costs. The cost of spray and dust is not quite one-half of the cost of seed. Central Ontario costs per acre were a little higher than those of Western

Ontario. Seed, commercial fertilizer, spray and dust values for Central Ontario are higher than for Western Ontario and harvesting costs were also higher. The thirty dollar difference in total costs between the two areas is due to the fact that Central Ontario growers produced potatoes more intensively, probably because of their location near the large metropolitan area around Toronto. The cost of production amounts to one hundred and forty-four dollars and sixty-two cents ($144.62) per acre.

TABLE 4—*Relation of size of enterprise to costs and time requirements.*

	No. of Farms	Aver. No. Acres of Potatoes per Farm	Aver. Cost of Production per Acre	Man Hours per Acre	Tractor Hours per Acre	Horse Hours per Acre
7 acres and under	27	4.7	$159.17	80	13	32
7.1 acres to 11.9 acres	20	9.2	160.23	77	18	25
12 acres and above	23	17.6	133.00	64	17	11

The cost of production decreased more than $25.00 per acre when 12 or more acres of potatoes were grown. The man hours per acre required decreased because of the replacement of horse time by tractor time. The horse hours per acre decreased and the tractor hours per acre increased as the size of enterprise increased, as you will note in table 4.

INJURY STUDIES ON IDAHO GROWN RUSSET BURBANK POTATOES*. PART I. SHIPPING AND HANDLING

WALTER C. SPARKS

University of Idaho Branch Station, Aberdeen, Idaho

(Accepted for publication May 12, 1950)

Idaho's Russet Burbank potatoes have frequently received undesirable criticism from consumers and retailers concerning the prevalence and seriousness of mechanical injuries appearing on the tubers in the retail markets. Since all Idaho potatoes must pass federal-state inspection before they can be shipped, such injuries must necessarily occur during shipping, handling, and retailing operations. In an attempt to determine the source of these injuries and how they can be prevented, two experimental shipments were sent and followed to retail markets. The first such shipment was from Idaho Falls, Idaho, to Los Angeles, California, in March, 1948. The second was from Aberdeen, Idaho, to Kansas City, Missouri, in March 1949 (6).

Similar experimental work in other states has indicated that a great deal of injury to tubers occurs during the shipping and handling operations. Most

* Part I of a project jointly sponsored by the University of Idaho and the Idaho Advertising Commission to determine the source of injuries to Idaho Russet Burbank Pototoes.

Published as Research Paper No. 312, Idaho Agricultural Experiment Station, Moscow, Idaho.

of this work has been done on early potatoes, and Rose (5), who gives a summary of the work done in various places, remarks that ". . . it is only after early potatoes leave the shipping point that the significance and importance of browning, heat injury, and mechanical injuries become evident."

De Loach and Moore (2), using late-crop potatoes in their shipping experiment, report that, although a certain amount of the bruising found in the sample packages could be attributed to damage while moving over the grading table, it was caused chiefly by handling practices.

Writing of shipments made into Chicago, Davis (1) reports that: "Bruises resulting within the car were one of the most important defects found at Chicago."

Hardenburg, (3) who carried on tests to determine the amount of injury incurred during the handling process at destination, reported that most of the injury caused during shipping and handling occurred after the potatoes had arrived on track. He found that in nineteen 30-pound samples of Green Mountain potatoes inspected at the car, replaced in the 100-pound sacks, and again inspected at the retail store there was an average increase of 48.16 per cent in the weight of tubers bruised but not damaged, an increase of 12.50 per cent in those damaged, and 7.20 per cent in seriously damaged tubers. He concluded from this study: "Not only is mechanical injury the most serious defect in potatoes marketed in Cleveland, but also more than half of the injury results from the present methods of handling after they arrive on track."

In 1938 (4) Hardenburg again presented data on injury upon arrival. In 58 samples of various varieties he found an average increase in injury of 17.32 per cent not damaged, 6.45 per cent damaged, and 2.34 per cent seriously damaged. From these data he concluded that, "although the percentage is perhaps of small concern before these potatoes are unloaded, it amounts to a significant item by the time they are presented to the consumer." In order to determine the extent of the injury occurring in Idaho-grown Russet Burbank potatoes between shipping point and terminal market, a preliminary study was carried on during March, 1948.

Los Angeles Shipment.

Three samples of each of five different types of containers were shipped to Los Angeles, California, from Idaho Falls, Idaho. The tubers used in this study were carefully graded and all readily-apparent injured and damaged tubers removed. The tubers were then carefully placed into 100-pound burlap sacks, 100-pound wooden export crates, 50-pound paper bags, and two types* of 10-pound consumer sized bags.

* One type of consumer pack was solid paper, and the other type was the open mesh bag made of twisted paper. Five of each type of consumer package were placed in paper master containers which were constructed to hold five 10-pound bags.

Each container was then carefully placed in the railroad car so as to be completely surrounded by containers of a similar type. One container of each type was placed on the bottom layer resting on the floor racks; a second was then put in the center layer between containers of a similar type; and the third was placed on the top layer.

Upon arrival at destination the experimental containers were removed from the car and transported in the normal manner to the wholesale warehouse where they were removed from the balance of the shipment and transported to a place somewhat similar to a retail outlet where the containers and contents were examined for injury. Check lots of each container type were kept at Aberdeen, Idaho, for the purpose of determining the amount of injury which might have been inflicted prior to shipment but which could not be detected until some dehydration or water loss had taken place from the injuries (Table 1).

TABLE 1.—*Effect of storage* on the per cent of readily apparent mechanical injuries present on tubers.*

Injury Type	Storage	100-lb. Burlap	100-lb. Wooden Crate	Paper 50's	Paper 10's	O. M.10's	Mean
Serious	Before	0.00	1.60	2.99	2.85	0.00	1.49
Bruises	After	4.23	4.19	4.44	0.89	1.91	3.13
Cuts	Before	0.00	0.00	3.98	2.85	0.00	1.37
	After	1.19	0.28	4.62	2.28	0.00	1.67
Shattered	Before	7.00	1.40	0.60	0.00	1.88	3.25
Ends	After	6.70	3.55	0.51	0.00	0.00	2.15
Hard	Before	5.00	4.00	2.31	5.33	1.25	2.51
Bruises	After	43.76	51.12	48.89	56.49	62.26	52.50

* The tubers were stored for approximately 3 weeks (3/1/48 to 3/24/48) in the University of Idaho, Aberdeen Branch Experiment Station potato storage.

From the data in table 1 it can be seen that a marked increase in apparent injury occurred during the storage period. When the three most serious categories (serious bruises, cuts, and shattered ends) were combined into one classification (culls) the mean per cent cullage found in the 100-pound burlap sample increased 5.12 per cent from 7.00 per cent before, to 12.12 per cent after storing, for three weeks. The 100-pound wooden crate sample increased 5.02 per cent during storage and the 50-pound paper sample increased 2.00 per cent. The 10-pound open mesh samples showed only a slight increase of 0.03 per cent whereas the 10-pound paper bag samples actually showed a decrease of 2.53 per cent. It is possible that some of the injuries

which were read as serious bruises before storing were read as hard bruises after storage, and *vice versa*, but in order to minimize this grading difference the same person read the tubers both times.

The presence of 1.88 per cent shattered ends in the open mesh samples before storage and 0.00 per cent after storage is very easily accounted for because of the increase after storage of almost the identical percentage in severe bruises. During storage the shattered ends could have lost enough moisture from the hairline cracks and bruised portions to have put the tubers in the severe bruise class.

The data from the hard bruise class indicate that there are a great number of hard bruises present at time of shipment which do not become readily apparent until the tubers have been stored for a short period. It also indicates that many bruises not readily apparent at time of shipment actually become culls because of moisture lost during a three-weeks' storage period. For this reason it was necessary to compare the mean injury of the three samples of each container type which were shipped to Los Angeles with that of the check sample which was kept at Aberdeen (Table 2).

These data show that the percentage of serious bruises increased at least 2.5 per cent in each case except in the open mesh bags where a decrease of 0.4 per cent was noted. The percentage of shattered ends increased in every type of container, from 0.2 per cent in the wooden crate to 5.4 per cent in the paper 50's. The percentage of cut tubers varied from an increase of 0.8 per cent to a decrease of 2 per cent, but since the tubers were placed in the class of most serious injury, any tuber having a small cut and a serious bruise or a shattered end would probably be placed in that more serious injury class instead of being placed in the cut class. For this reason, serious bruises, cuts, and shattered ends were combined into one class (culls); hard bruises and large cracks into a second (heavy injury); medium cracks and small bruises into a third (medium injury); small cracks and skinned into a fourth (slight injury); and the uninjured left in a class by itself. This created a new table (Table 3) which made it much easier to determine the amount of injury caused by shipping and handling.

From this it can be seen that with the exception of the 100-pound wooden crate each type of container tested showed an increase in the percentage of heavy injury and culls. The per cent increase in injury in these two categories ranged from 5.58 with open mesh 10's to 16.74 in paper 50's. The 100-pound wirebound crate showed a decrease of 0.71 per cent for these two categories. The total for all container types showed an increase in per cent cullage of 18.65 or a mean of 3.73 per container. The total per cent increase in heavy injury was 23.08 or a mean of 4.61 per container. These data indicate that

TABLE 2.—*Per cent and type of shipping and handling injuries found on Russet Burbank Potatoes in various types of containers, March 1948.*

Type of Container	Examined Where	Type of Injuries Found (Per cent of Total Weight)									
		Sr. Br.	Cuts	Sh. End*	H. Br.	Lge. Cr.	Med. Cr.	Sm. Br.	Sm. Cr.	Sk.	Uninjured
100-lb. Burlap	L. A.	6.84	0.11	7.70	47.25	6.48	22.34	6.44	2.82	0.00	0.00
	Ab. Ck.	4.23	1.19	3.15	43.76	6.62	18.24	16.82	4.67	0.00	1.30
	Difference	2.61	1.08	4.55	3.49	0.14	4.10	10.38	1.85	0.00	1.30
Wooden Crate	L. A.	6.93	1.06	3.72	28.75	10.01	29.69	6.48	5.78	0.31	0.42
	Ab. Ck.	4.19	0.28	3.55	51.12	2.24	19.81	11.68	5.23	0.65	1.50
	Difference	2.74	0.78	0.17	12.17	7.77	9.88	5.20	0.55	0.34	0.98
Paper 50's	L. A.	7.08	2.27	5.94	59.36	2.16	17.15	7.18	1.91	0.00	0.26
	Ab. Ck.	4.44	4.62	0.51	48.89	1.71	21.54	11.28	5.13	1.03	0.85
	Difference	2.64	1.35	5.43	10.47	0.45	4.39	4.10	3.22	1.03	0.59
Open Mesh	L. A.	1.48	0.24	1.28	67.32	3.26	18.75	7.08	0.20	0.78	0.36
	Ab. Ck.	1.91	0.00	0.00	62.26	3.83	22.13	5.36	4.50	0.00	0.00
	Difference	0.43	0.24	1.28	5.06	0.57	3.38	1.72	4.30	0.78	0.36
Paper 10's	L. A.	3.46	0.20	0.58	71.95	3.18	19.19	1.44	0.00	0.00	0.00
	Ab. Ck.	0.89	2.28	0.00	56.49	9.02	26.26	2.08	2.28	0.69	0.00
	Difference	2.57	2.08	0.58	15.46	5.84	7.07	.64	2.28	0.69	0.00

* Many tubers in this class had shatter bruises on the end, some of which had dried and had an appearance similar to tubers having dry rot.

TABLE 3.— *Per cent increase in injury (weight basis) produced during the shipping and handling of Idaho Russet Burbank Potatoes from Idaho Falls, Idaho to Los Angeles, California in March 1948.*

Type of Container	Culls	Heavy Injury	Medium Injury	Slight Injury	Uninjured
Burlap 100's	+6.08	+3.35	—6.28	—1.84	—1.30
Wooden Crate 100's	+3.69	—4.40	+4.66	+0.21	—0.98
Paper 50's	+6.72	+10.02	—8.49	—4.25	—0.59
Paper 10's	+1.07	+9.62	—7.71	—2.97	0.00
Open Mesh 10's	+1.09	+4.49	—1.66	—3.52	+0.36
Total	+18.65	+23.08	—19.48	—12.37	—2.51

even though the amount of injury varies as the type of container varies, the over-all trend is that there is an increase in the amount of readily apparent injury caused by shipping and handling in addition to that appearing after storage.

Kansas City Shipment:

The trial shipment from Aberdeen, Idaho, to Kansas City, Missouri, during March, 1949, differed from the shipment to Los Angeles in that all mechanical injuries present on the tubers at the time of shipment were marked with an idelible pencil, and samples were taken at each operation which might cause injury.

From the experience and information received during the Los Angeles shipment it was deemed necessary to ship only marked tubers to Kansas City. In order to accomplish this, each individual tuber was carefully examined and each injury found thereon marked with an indelible pencil. It was then assumed that each unmarked injury found at the terminal market was due to some phase of the shipping, handling, or retailing operations. Two or more samples of each type of container filled with marked tubers were left at the Aberdeen Station as a check against injuries which might show up after a period of storage but which were not noticeable at time of marking and shipping. Before marking, the tubers used in this study were washed and allowed to dry, then stored for a period varying from 10 days to 2 weeks to allow any injuries incurred during the washing process to become apparent. Each tuber was then examined and all injuries marked. After marking each injury, the potatoes were handled with extreme care and placed in the containers which, in turn, were gently handled during the process of loading the railroad car. During the car's loading, some of the check lots which were to remain at Aberdeen were transported to the railroad car and back to

the storage cellar in order to determine more accurately the amount of injury which the test tubers had received during the handling and loading processes.

The containers used for this test included those used during the Los Angeles shipment and four additional types. The types of containers used in this study are listed below with the name which will be used throughout this paper and the accompanying more technical description of each:

(1) Burlap—The common burlap sack which holds 100-pounds of bulk tubers.

(2) Wirebound 100—The commonly used wirebound wooden veneer crate holding 100-pounds of bulk potatoes and used for export and government shipments.

(3) Wirebound 75—A wirebound wooden veneer crate holding 75-pounds of bulk potatoes.

(4) Nailed 75—A nailed wooden crate holding 75-pounds of bulk potatoes.

(5) Paper 50—A paper bag holding 50-pounds of bulk potatoes.

(6) Paper 10—A paper master container almost the same as the paper 50 but lighter in construction and holding five 10-pound consumer packages.

(7) Wirebound 10—The same as the wirebound 75 but holding six 10-pound consumer packs.

(8) Nailed 10—The same as the nailed 75 but holding six 10-pound consumer bags.

Operations during shipping, handling, and retail processes where injury might occur were divided into three main groups: (1) the process of transporting the tubers from one point to another in the railroad car; (2) the act of unloading the railroad car, the handling and hauling to the wholesale warehouse; and (3) the handling and hauling necessary during the retailing operation.

Six samples of each of the five types* of bulk containers (Figure 1) and the three types of master containers (Figure 2) were shipped from Aberdeen, Idaho to Kansas City, Missouri. Two of each of these container types were removed from the railroad car on track at destination and stored for approximately 1 week before reading. The other four samples of each container type were handled by the regular methods and crew in the wholesale warehouse. At this point two more samples of each container type were removed from the shipment and stored for later examination. The remaining two samples of each container type were sent through the regular produce handling channels to the retail store where they were collected and stored with the other samples until read for injury.

* Two different styles of nailed wooden crates were used but are considered as a single type of box.

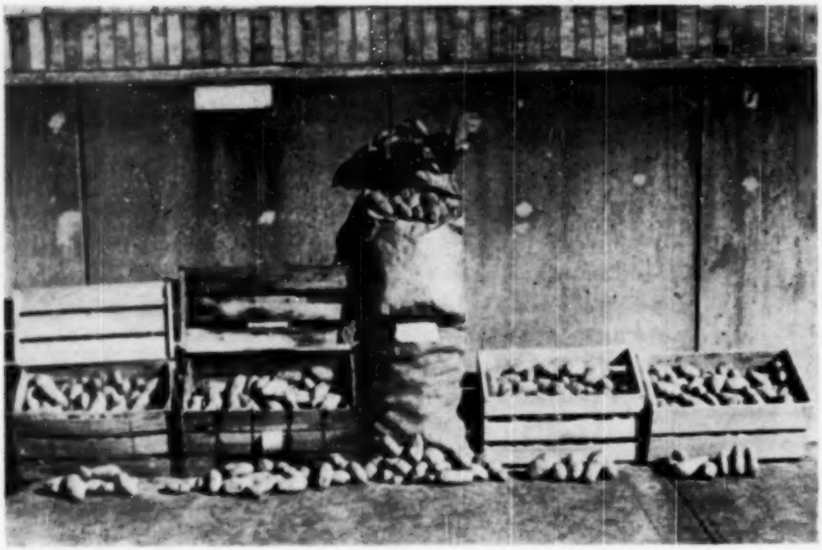

Fig. 1—Types of bulk containers used in the shipping trial to Kansas City, Missouri, March, 1949.

Fig. 2—The author showing the various types of master containers used in the shipping trial to Kansas City, Missouri, March, 1949.

The measure of protection afforded by each type of container and the measure of the amount of injury present at each point of sampling was determined by recording for each sample the number and weight of tubers in each injury class (Figure 3). Percentage of injury and injury index values were calculated from these tabulations.

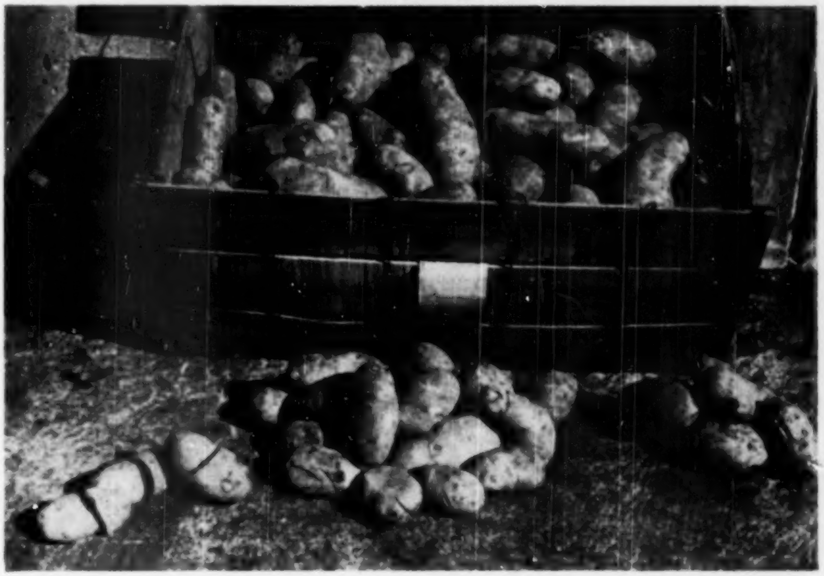

Fig. 3—The culls (3 tubers on the left in front of crate), large cracks (pile in center), and hard bruises (tubers on right) found in one retail sample of the wirebound 100.

The percentage of the various types of injury found to be present in each type of container at the different points of sampling is given in table 4. These data show that the percentage of injured tubers increased and the percentage of uninjured tubers decreased as the number of handlings increased. On the track at destination the tubers in each of the eight container types revealed the presence of some small bruises, and each except those in wirebound 75, the nailed 75, and the wirebound 10 showed some medium cracks. The nailed 75 and the paper 10 were the only two which did not reveal hard bruises. Large cracks appeared in only two samples: one sample of the wirebound 100, showing 1.28 per cent, and one sample of the paper 50 which had 0.99 per cent. Culls* also were present in only two samples; the wirebound 100 which showed 0.51 per cent, and the paper 10 where 0.89 per cent was found.

The amount of injury present at the wholesale warehouse was greater than that found in the samples taken on the track at destination. The burlap

* Culls as used herein designate tubers broken in two, or seriously bruised.

showed 0.76 per cent large cracks; the wirebound 100 2.07 per cent; and the paper 10 showed 3.36 per cent at the wholesale warehouse as compared with 1.28 per cent in the wirebound 100; and 0.99 per cent in the paper 50 on the track at destination. The only container which had no hard bruises at the wholesale warehouse was the wirebound 75. Neither the nailed 75 nor the paper 10 contained such bruises on the track at destination. Similarly the only container at the wholesale warehouse in which no medium cracks were found was the nailed 75, whereas none was present in the wirebound 75, the wirebound 10, or the nailed 75 on the track at destination.

From the wholesale warehouse to the retail outlet the percentage of injured tubers present in each container again increased. The paper 10 and the nailed 10 were the only containers in which culls were found at the wholesale warehouse, but the nailed 10 was the only container type not containing culls at the retail outlet, and the wirebound 75 was the only one showing no large cracks. All container types contained some hard bruises ranging from a mean of 0.47 per cent in the wirebound 10 to 8.93 per cent in the paper 50. The percentage of hard bruises at the retail outlet in the other containers were: wirebound 100, 2.68; wirebound 75, 2.88; nailed 75, 3.53; burlap, 5.13; paper 10, 5.32; and the nailed 10, 7.66 per cent.

In order to compare the points of injury without regarding the container type, the mean of each injury type for all containers at each point of sampling was calculated (Table 4). The comparative amounts of uninjured tubers showed a decrease from 59.79 per cent on the track at destination to 45.82 at the wholesale warehouse, to only 24.43 per cent at the retail outlet. Conversely the mean percentage of each type of injury increased as the number of handlings increased. The mean percentage of hard bruises found in the containers increased from 0.84 on track, to 1.53 at the wholesale warehouse, and to 4.57 at the retail outlet. The percentage of large cracks at the three points increased from 0.14 to 0.39 and then to 2.10 respectively; likewise, the percentage of culls increased from 0.01 to 0.11 and then to 1.00 at these same three points. In other words, the percentage of injury present at the wholesale warehouse was, in relation to that present on track at destination, 146 per cent on medium cracks, 182 on hard bruises, 278 on large cracks, and 121 per cent on culls. Likewise, that present at the retail outlet was much greater than at the wholesale warehouse. At the retail outlet the medium cracks were 499 per cent, the hard bruises, 299; the large cracks, 539; and the culls 909 per cent of those present at the wholesale warehouse. This shows also that there was a greater increase in injury between the wholesale warehouse and the retail outlet, than between the shipping point and on track at destination, and between on track at destination and the wholesale warehouse.

TABLE 4.—*Effect of shipping and handling Idaho-grown Russet Burbank Potatoes on the type and per cent of injuries found on tubers at Kansas City, Missouri during March 1949 in various types of containers at three points of sampling.*

Container	Uninjured		Small Cracks		Small Br.		Medium Cr.		Hard Br.		Large Cr.		Culls*	
Sample Number	1	2	1	2	1	2	1	2	1	2	1	2	1	2
On Track at Destination														
Burlap	73.91	61.50	13.77	31.00	7.25	5.00	2.42	2.25	2.66	.25	0.00	0.00	0.00	0.00
Wirebound 100	34.10	58.19	31.29	19.65	25.64	21.16	5.90	0.00	1.28	1.09	1.28	0.00	.51	0.00
Wirebound 75	64.80	50.09	25.34	30.88	9.87	13.68	0.00	0.00	.99	.35	0.00	0.00	0.00	0.00
Nailed 75	57.99	64.47	28.13	25.33	13.89	10.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paper 50	67.33	41.58	20.79	43.50	10.89	8.91	0.99	2.48	0.00	2.48	0.00	0.99	0.00	0.00
Paper 10	59.76	63.67	17.26	23.38	19.38	12.06	3.60	0.00	0.00	0.00	0.00	0.00	0.00	.89
Wirebound 10	68.94	77.69	28.14	18.92	2.92	2.56	0.00	0.00	0.00	.79	0.00	0.00	0.00	0.00
Nailed 10	56.88	55.72	30.12	30.02	9.04	14.26	.41	0.00	3.54	0.00	0.00	0.00	0.00	0.00
Mean	59.79		26.09		11.67		1.16		.84		.14		.09	
Wholesale Warehouse														
Burlap	49.62	47.38	37.91	42.14	6.11	8.48	3.05	.75	2.54	1.25	.76	0.00	0.00	0.00
Wirebound 100	30.31	48.36	46.63	31.23	13.47	19.65	5.96	.76	1.55	0.00	2.07	0.00	0.00	0.00
Wirebound 75	53.25	45.30	32.83	37.92	11.15	16.44	2.79	.34	0.00	0.00	0.00	0.00	0.00	0.00
Nailed 75	70.49	43.79	17.70	39.87	10.49	14.38	0.00	0.00	1.31	1.96	0.00	0.00	0.00	0.00
Paper 50	20.90	39.92	31.34	38.42	44.78	20.69	1.49	0.99	1.49	0.99	0.00	0.00	0.00	0.00
Paper 10	51.39	43.33	24.54	26.87	12.09	22.92	6.53	0.00	2.67	3.82	1.90	1.46	.89	0.00
Wirebound 10	59.92	43.07	24.98	49.22	13.17	6.35	1.94	0.00	0.00	3.07	0.00	0.00	0.00	0.00
Nailed 10	47.07	39.03	29.58	44.20	17.43	15.37	1.71	.81	3.37	.42	0.00	0.00	.85	0.00
Mean	45.82		34.71		15.81		1.70		1.53		.39		.11	
Retail Outlet														
Burlap	13.79	40.60	49.50	41.85	8.86	5.01	13.79	4.01	5.41	4.76	3.69	3.00	4.93	.75
Wirebound 100	7.14	15.30	47.95	55.10	19.38	15.56	16.83	5.61	2.04	3.31	4.48	5.10	1.75	0.00
Wirebound 75	32.67	26.15	45.33	44.67	12.67	25.09	6.00	0.00	2.67	3.09	0.00	0.00	.67	0.00
Nailed 75	20.75	27.89	50.17	42.86	16.05	22.45	6.02	4.08	5.02	2.04	1.00	0.00	1.00	.68
Paper 50	8.00	25.37	18.50	40.00	11.50	26.34	39.50	2.92	12.50	5.36	8.00	0.00	2.00	0.00
Paper 10	28.69	20.20	29.60	32.87	26.62	27.24	5.03	12.73	6.81	3.83	1.82	3.13	1.43	0.00
Wirebound 10	37.57	31.42	40.78	46.60	9.06	18.81	6.77	3.18	.93	0.00	2.12	0.00	2.78	0.00
Nailed 10	35.05	19.30	25.20	51.27	29.12	14.58	.41	8.91	9.39	5.92	0.00	.86	0.00	0.00
Mean	24.43		41.39		18.00		8.49		4.57		2.10		1.00	

* Culls as used herein designate tubers broken in two, or those seriously bruised.

To facilitate the analysis of these data and to provide a single figure with which to work, an injury index was calculated from the aforementioned tabulated data. This injury index was obtained by multiplying the value* of each injury class by the weight of the tubers in the class; these products were then added and the sum multiplied by 100. This figure was then divided by the weight of the sample to give the injury index for that sample. Injury index is, therefore, a combined measure which combines into one figure the percentage and severity of injury. These injury indexes are presented in tabular form in table 5.

It will be noticed that there is considerable variation between duplicate samples of each container type at the same point of sampling, but even with this wide variation some types of containers differed significantly from others. The nailed 75, the wirebound 10, and the wirebound 75 each had a significantly smaller injury index figure than did either the wirebound 100 or the paper 50. Both the wirebound 10 and the wirebound 75 had a significantly smaller injury index than the paper 10, but because of the wide variation between samples no container types used in this test differed significantly from the 100 pound burlap sack. One significant difference which is noteworthy is that between the wirebound 100 and the wirebound 75. These two containers differed in only two respects, size of container and thickness of material used in the construction. The wirebound 75 held 25 pounds fewer potatoes, but the veneer from which it was constructed was 1/6 and 1/8-inch material. The wirebound 100 was constructed of 1/4-inch material. This may indicate that the size of the package is an even more important factor than the thickness of the material used in construction. The wirebound 100 constructed of 1/4 inch material resulted in a significantly higher injury index figure than the wirebound 75 constructed of lighter 1/8 and 1/6-inch material.

Since the injury indexes of all samples which remained at Aberdeen were less than one, it was evident that no injury had resulted from storage, hauling to the car, or loading at the shipping point, and that all injury present on track at the destination was caused by shipping and was not due to injury received prior to shipment. It will be noted that since the injury index at shipping point was less than one and the injury index on the track at destination was 81.64, a highly significant increase in injury index between the shipping point and on track at destination had occurred. Even though the injuries found on track at destination were not of such magnitude as to make the tubers unsalable or detract greatly from their appearance, injuries

* The value of each injury class was determined by a series of factors which included the per cent peeling waste per injury type, the per cent rot and moisture lost during storage, the percentage of times each injury type was the inoculation court for rot organisms, the consumer appeal or disapproval of each injury type, and the prevalence of each injury type present in storage. A paper is in preparation which gives some of the data used to determine these class values.

TABLE 5.—*Effect of type of container and point of sampling upon the injury index of the tubers from duplicate samples caused by shipping and handling Idaho Russet Burbank Potatoes from Aberdeen, Idaho to Kansas City, Mo. March 1949.*

Container Type	On Track at Destination			Wholesale Warehouse			Retail Outlet			Total	Mean†
Sample No.*	1	2	Mean	1	2	Mean	1	2	Mean		
Burlap	74.22	59.75	66.99	108.29	83.83	96.06	500.98	207.03	354.01	1034.10	172.35
Wirebound 100	195.20	94.03	144.52	163.39	93.98	128.69	370.74	239.43	305.09	1156.77	192.79
Wirebound 75	64.85	75.42	70.14	80.23	88.94	84.59	173.54	150.84	162.19	633.82	105.63
Nailed 75	69.80	55.93	62.87	55.72	92.81	74.27	243.62	185.01	214.32	702.89	117.15
Paper 50	58.41	122.34	90.38	188.03	115.34	151.69	595.50	187.22	391.36	1266.84	211.14
Paper 10	93.40	104.06	98.73	193.16	155.73	174.45	301.51	263.49	282.50	1111.35	185.22
Wirebound 10	36.90	34.50	35.70	74.19	98.97	86.58	281.91	118.93	200.42	645.50	107.57
Nailed 10	94.70	72.80	83.75	166.92	98.56	132.74	208.51	211.66	210.08	853.15	142.19
Total			1306.31			1858.09			4239.92		
Mean‡			81.64			116.13			265.00		

* Sample 1 was always read by one person, whereas sample 2 was always read by another.

† The least difference between container means to be significant at 19:1 odds are 75.55; at 99:1 odds are 105.20.

‡ The least difference between points of sampling means to be significant at 19:1 odds are 46.27; at 99:1 odds are 64.63.

were present in large enough quantity to give a highly significant increase in injury index.

These data also show that the injury found on the samples at the wholesale warehouse was not significantly greater than that present on track at destination but that there is a highly significant difference between the injury index at the retail outlet and that present at the wholesale warehouse. The increase in injury index from 116.13 to 265.00 indicates an increase of 146.87 where 64.63 is all that is required for the difference to be highly significant. This seems to indicate that the greatest amount of the injury caused by shipping and handling occurs between the wholesale warehouse and the retail outlet.

Because of the fact that the two samples of each container type were merely duplicate samples and not replications it became necessary to analyze the data as a sampling study and use the interaction variance to test the significance of the differences between container types and sampling points. Therefore, it was not possible to obtain significance on the interaction between the points of sampling and the types of containers, but there are certain trends in this direction which should be pointed out. For instance, the mean injury index on burlap was quite low on the track at destination and increased only a small amount enroute to the wholesale warehouse but increased by almost three and one-half times in completing the journey to the retail outlet. In comparison to this the wirebound 100 had a mean injury index twice as great as burlap on the track at destination, but had an injury index which was actually less than the burlap at the retail outlet. This indicates that a definite interaction effect is present. The wirebound 75 and the wirebound 10 also show a difference in interaction between the point of sampling and the type of container. The wirebound 10 has a mean injury index of 25.7 on track at destination as compared with 70.14 for the wirebound 75, whereas at the wholesale warehouse they showed 86.58 and 84.59, respectively; and at the retail outlet the magnitude was reversed so that the wirebound 75 showed 162.10 and the wirebound 10, 200.42. These trends, even though they can not be compared for significance, do point out that certain types of containers allow injury to occur during one phase of the shipping and handling process; whereas others allow it to occur during other operations.

Since the injury index figure includes all types and kinds of injury from the small cracks and bruises which were not readily apparent to the hard bruises and culls which scored against the inspection grade, it was regarded as the most accurate figure on injury that could be obtained, but from the practical standpoint it might be misleading. For this reason, a table was prepared which considered only those tubers which were badly damaged (Table 6). It will be noted from this table that there were no significant differences among container types. Even though the burlap sack at the retail

TABLE 6.—*Effect of shipping and handling Idaho Russet Burbank Potatoes on the percentage of badly damaged tubers present in duplicate samples of various types of containers at three points of sampling.*

	Point of Sampling										
Type of Container	On Track			Warehouse			Retail			Total	Mean
Sample No.	1	2	Mean	1	2	Mean	1	2	Mean		
Burlap 100	0.00	0.00	0.00	0.76	0.00	0.38	8.62	3.95	6.29	13.33	2.22
Wirebound 100	1.79	0.00	0.89	2.07	0.00	1.04	6.59	5.10	5.85	15.55	2.59
Wirebound 75	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00	0.34	0.67	0.11
Nailed 75	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.68	1.34	2.68	0.45
Paper 50	0.00	0.99	0.50	0.00	0.00	0.00	10.00	0.00	5.00	10.99	1.83
Paper 10	0.00	0.89	0.45	2.79	1.46	2.13	3.25	3.13	3.19	11.52	1.92
Wirebound 10	0.00	0.00	0.00	0.00	0.00	0.00	4.90	0.00	2.45	4.90	0.82
Nailed 10	0.00	0.00	0.00	0.85	0.00	0.43	0.00	0.86	0.43	1.71	0.29
Total			3.67			7.93			49.75		
Mean			0.23			0.50			3.11		

The least difference between points of sampling means to be significant at 19:1 odds are 1.41; and 99:1 are 1.96.

The difference between container type means is non-significant.

outlet contained a mean of 6.29 per cent badly damaged tubers and the wirebound 75 contained only 0.34 per cent, no significant difference existed. This was due to the variation between samples.

The differences between the various points of sampling were large enough so that even with this wide sample variation, significant differences still existed. The least difference between means to be considered significant was calculated to be 1.41. This figure showed that there was no significant difference in the percentage of badly damaged tubers between the shipping point and the sample taken on track at destination. It also showed that no significant difference in badly damaged tubers had occurred between the shipping point and the wholesale warehouse, but the movement of the tubers from the wholesale warehouse and the retail outlet caused so much damage to the tubers that there was a highly significant increase in badly damaged tubers between the retail outlet and any previous sampling point. So, in general, the same results are found whether the per cent of badly damaged tubers or the injury index is used. Both methods show a significant increase in injury because of the shipping and handling, with the transfer of tubers from the wholesale warehouse to the retail outlet causing the greatest amount.

Discussion and Summary

The preliminary shipping test to Los Angeles, California, in March, 1948, indicated that considerable injury to Idaho Russet Burbank potatoes was occurring after the potatoes were placed in the railroad cars and started on their way to market. This test also indicated that the protective ability of various types of containers differed and that considerable injury which had occurred during the hauling, grading, and packaging operations prior to shipment was not readily apparent until the tubers had been stored for a period of time. This revealed the necessity of shipping only uninjured tubers which had been stored for a period of time after washing and handling. In the Kansas City shipment this was accomplished by marking each injury on each individual tuber with an indelible pencil.

The Kansas City shipment showed that some types of containers were superior to others, but because of large variations between samples none in this test proved to be significantly better or significantly worse than the 100-pound burlap bag. This shipment showed that regardless of the type of container used, an increase in injury occurred each time the potatoes were handled. It also pointed out that the greatest increase in injury occurred between the time the potatoes were in the wholesale warehouse and the time of their appearance on the retail shelves for sale.

These studies emphasize the need for much more careful handling of high quality Idaho Russet Burbank potatoes by personnel at destination in order for the consumer to obtain a high quality product. If the potatoes do not re-

ceive careful handling during the shipping and retailing operations they will be offered to the consumer in poor condition and in many cases as poor quality potatoes, regardless of how they are originally packed and how high the quality at the shipping point.

Literature Cited

1. Davis, G. B. 1949. Quality loss in marketing Oregon early-crop potatoes. Oreg. Agr. Exp. Sta. Bull. 468, 32 pp.
2. DeLoach, D. B., and Moore, James C. 1948. Trial shipments of Oregon late-crop potatoes. Oreg. Agr. Exp. Sta. Bull 460, 32 pp.
3. Hardenburg, E. V. 1937. Grade analysis of potatoes on the Cleveland market. Amer. Potato Jour. 14(4):107-116.
4. ————. 1938. Potato tuber bruising in the Cleveland and Rochester markets. Amer. Potato Jour. 15(8):213-219.
5. Rose, D. H. 1946. Handling and shipping early potatoes. U.S.D.A. Circ. 744, 44 pp. (illus.)
6. Sparks, Walter C. 1950. Destination findings of potatoes. Proc. Northwest Persh. Loss Prev. Short Course, 5 pp. (illus.) (Process).

SECTIONAL NOTES

Indiana

Our harvesting operations have begun with both the Irish Cobbler and the Chippewa varieties, using some vine killer to get the vines out of the way. Both the quality and the yield of the crop are better than we have experienced in the last ten or fifteen years and the harvesting conditions are very favorable for nice clean potatoes. The tubers are a very good size and, as I said above, we have good yields.

So far no reports of late blight have come to our attention. As you well know, whenever a grower starts in with a pest control program and follows it through religiously, he is going to have very few, if any, disease or insect problems.

On July 25th, our potato growers held a meeting at the Gumz Farm, near North Judson, and, of course the marketing situation was brought to their attention. We find that our growers are entirely opposed to the marketing agreements, to Government control, and to purchase price. So we feel that they should not be grouped with the other north-central states, which are surplus areas. Our potato growers seem happy and contented and I personally often wonder why it is necessary to agitate a peaceful group of honest citizens.—W. B. Ward.

Idaho

Potatoes in the eastern part of the state are well ahead of where they were at this time last year, despite a late start. The weather has been generally cool and, barring an early frost, good yields of bakers may be expected.

More than 11,000 acres are entered for certification this year. This is the largest acreage since 1946. The first inspection indicates that leafroll spread was not too serious in most sections last year.

Shipments from western Idaho were held back by the maturity regulations put in under the marketing agreement. Early Russets are showing some second growth which will reduce the percentage of Number One's. Leafroll spread has been negligible in western Idaho up to the present time.—R. D. PELKEY.

MAINE

Maine potato prospects are excellent. The 1949 yield of 450 bushels per acre was a record but our July crop estimate is the same. Aroostook has had plenty of moisture and very few reports of late blight have been brought to our attention.

The P. and M. A. has begun farm checking. Estimates are that 97 per cent of the farmers are complying with acreage allotments. The outlook for prices is not good. With only New Jersey and Maine, of the Eastern States, as yet eligible for price support a real problem arises as to how potato prices can be supported. Other states may sell just under support and therefore the crops in New Jersey and Maine may be bought by the department. This would indeed be unfortunate, for Maine, at least, wants to, and can be expected to fight, to retain its markets rather than to lose them to states which have no marketing agreement and are thus without support.

The new variety of Kennebec is undergoing a crisis just now. Spindle tuber is showing up and many fields are not passing certification because of this disease. Spindle tuber is very hard to distinguish in the field so roguing is a real task. Many farmers are beginning to wonder if Kennebecs are so susceptible to spindle tuber that it will wreck the variety. If yields are large, however, spindle tuber will probably be overlooked.

John Chandler, Massachusetts Commissioner of Agriculture, was the principal speaker at the Field Day held on August 10th at the Experimental farm at Presque Isle.—VERNE BEVERLY.

NEW JERSEY

New Jersey potato growers are harvesting one of the finest crops on record. Both the quality and the yields are excellent. Nearly all the Cobblers have been harvested; Chippewas are moving slowly and some growers are now harvesting Katahdins. Harvesting operations will undoubtedly be greatly slowed down by low prices.

The potato marketing agreement under which New Jersey potatoes are sold has prevented low grade potatoes from reaching the market, therefore, most of the potatoes that are being offered to the trade are the U. S. No. 1, Size A, grade.

The commercial quotations are generally below support prices. Since Long Island, Maryland, Delaware, and Pennsylvania do not have price support they are compelled to sell all potatoes to the trade, therefore, the prices in these areas have dropped well below the $1.55 support price. For this reason it looks as though New Jersey growers will sell most of their crop to the government, whereas our neighboring states have the indirect benefit of price support without any of the regulations. New Jersey and Maine are the only states in the Northeast with price support and they will undoubtedly receive much unfavorable criticism because of the large quantities of potatoes purchased in these states by the government. The fact that the government has few outlets for these potatoes leads to dumping and waste which causes both producers and consumers much concern and gives the potato industry a bad reputation.

With potato prices so low and production costs at a high level, high yields are necessary if growers are to get back the cost of production. It is quite likely that there will be no price support for any potatoes in 1951 and growers will once again be back on their own. Let us hope they will all plant cautiously, harvest slowly and pack carefully.—J. C. CAMPBELL.

NEW YORK

August 31st has been set for the referendum of the Marketing Agreement. There seems to be so little interest among our growers that the chances of its adoption are not good.

Potato crops have never looked better on the 1st of August. We have had plenty of moisture and the weather has been relatively cool, resulting in ideal growing conditions. The next six weeks will tell the story about the crop, but we expect a high yield per acre.

Our acreage is down at least 6 per cent lower than last year. Some large growers reduced their acreage materially, whereas others increased theirs.

The seed acreage is slightly above last year and with a better quality of foundation stock it is expected there will be ample supplies. Arrangements are being made to grade seed more carefully than usual.

The New York Cooperative Seed Potato Association, Inc., is branching out in its activities and will can small potatoes as well as pre-peel for the institutional trade. The sale of table stock has developed rapidly with this organiza-

tion during the past ten years and its directors have concluded that now is the time for growers to market their own crop in as many ways as possible.—H. J. EVANS.

OREGON

The potato crop in the Klamath Basin was planted about ten days later than usual because of the late cold spring weather. Growing conditions have been particularly favorable and the crop is in good shape at the present time.

Our acreage is about the same as last year. The first field inspection for certification is nearly completed. The disease condition is excellent because of its absence. July temperatures have been above normal, and heavy irrigation has been required.—C. A. HENDERSON.

SOUTH DAKOTA

Potatoes look excellent in the commercial area of South Dakota, and we are anticipating a good crop. The acreage is down to 15,000 in the state, with approximately three-quarters of this acreage in the Northeastern part. The average acreage for South Dakota for the period between 1938-1947 was 30,-000 acres. So it can readily be seen that the acreage has been cut in half.

A total of 4,083 acres has been entered for certification, compared with 5,229 acres entered in 1949, and more than 7,000 acres in 1948.

Dr. L. T. Richardson, who came to South Dakota State College from Canada in 1949, is supervising the field inspections. Rejections have been low and our prospects are for a fine lot of low virous, certified seed.

The South Dakota commercial potato area is under a marketing agreement, in order that growers will be eligible for price support. This will start at $1.25 per cwt. in September and increase to $1.70 per cwt. in March, 1951.

Harvesting of our early stock will begin about August 21st, but the general harvest will not get under way until September 15th.—JOHN NOONAN.

VERMONT

The total acreage planted in Vermont this year was estimated at slightly over 5,000. This is the lowest on record but is apparently with the general trend. Approximately 2,000 acres are in the commercial class. In most cases planting was done within the normal period and good stands are general. Heavy fertilization and close planting were practiced by most growers.

No late blight had been reported up to August 1st and virus disease infection appears to be light.

About 500 acres were enrolled for seed certification with Katahdin, Green Mountain and Houma varieties accounting for all, with the exception of a few fields.

Vermont growers have been waiting with much interest to know when and if a referendum is to be taken on the question of a marketing agreement for the area including Vermont. The sentiment recorded at a statewide meeting of potato growers last spring on this question was definitely against an agreement. Practically no digging can be expected before September except for a few growers who push Cobblers through for an early market.—Harold L. Bailey.

Province of Ontario

Reports from practically all counties and districts indicate that prospects are excellent for this year's late potato crop. An exception comes from the northwestern section of the Province, where periods of heavy rainfalls have damaged fields in Thunder Bay, Rainy River and Kenora Districts.

Conditions are extremely suitable for the development of late blight and this disease has already been reported from Norfolk, Prescott, and Dufferin Counties, and a few other scattered areas. If moist conditions continue with temperatures between 50° and 85° F. the need for adequate protection by spraying or dusting will be a necessity in order to prevent heavy crop losses.

There are yet some potatoes from the early crop to be marketed from south-western Ontario. This has interfered very materially with demands for the intermediate crop from Ontario, York Peel and Simcoe Counties in the central area. The prices for our growers have dropped to a very low level, with some buyers offering less than one dollar per 75-pound bag. Basket prices in most retail shops continue at approximately the same price as that of a few weeks ago, with a regular six-quart size varying from 10 to 11 pounds and selling at 39 cents.

Between 250 and 300 Ontario people attended the Seventeenth Annual Field Day on August 3rd in New York State, organized by the Empire State Potato Club. Many are looking forward to the Annual Potato Field Day on September 6th in Dufferin County to be held again this year on the farm of Allan Laverty, Reddickville.

A survey of commercial potato fields for bacterial ring rot will get underway towards the end of this month.—R. E. Goodin.

Canada

The acreage of potatoes entered for certification in Canada in 1950 exceeds that entered in 1949 by more than 1,000 acres. The acreage entered in 1950 amounts to 74,000, 26,000 of which is of the Katahdin variety. There has been a decrease of more than 2,000 entered for inspection in Prince Edward Island, but this is offset by an increase of approximately the same amount in New Brunswick. Other provinces show slight increases, with the exception of Saskatchewan.

Reports to date show that late blight is showing up in the eastern provinces; whether or not this disease will develop into an epidemic will depend upon weather conditions during the next few weeks. In general, weather conditions have been favorable for the development of late blight, but these conditions have also been favorable for the development of the potato crop. Virus diseases, although common, are not present in high percentages.—J. W. Scannell.

Announcing the

THIRTY-SEVENTH ANNUAL MEETING

of

THE POTATO ASSOCIATION OF AMERICA

Hotel Peabody **Memphis, Tenn.**

December 1-2-3, 1950

Joint Sessions will be held with the American Phytopathological Society. Titles and abstracts of papers for presentation at the meeting should reach Dr. Ora Smith, Secretary, Department of Vegetable Crops, Cornell University, Ithaca, New York, by November 1.

Two copies of each abstract of not more than 200 words are requested. Please specify the type of projection equipment required. Limit papers to 15 minutes.

Make your reservations early.

Room rates are as follows: $3.00 to $9.00 single rooms; $4.00 to $12.00 double room (double bed), $7.00 to $12.00 (twin beds).

University Microfilms
313 North 1st St
Ann Arbor Michigan